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SOIL SCIENCE

Report on the Second International Congress of Soil Science. Russia, 1930.

by

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Research.

ABERDEEN.

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Report on the Second International Congress of Soil Science.

Leningrad - Moscow, U.S.S.R.

20th July, 1930.

BY DR. R. HART. B.Sc., Ph.D.

Macaulay Institute for Soil Research, Aberdeen.

Report of Meetings of Commission V.

The Congress opened in Leningrad on the 20th July in a plenary meeting at the Academy of Science. Dr. Hissink, Holland, presided in the absence of Dr.K.K. Gedroiz through ill-health. The official welcome was replied to by members from the various countries represented at the Congress. The meeting then adjourned, the members going to the various Commissions.

The Fifth Commission met in the Dokuchaiev Soil Institute. This institute has been recently opened (1930) and the following departments have been set up:-

(1) Department for investigating physical, chemical and biological soil problems.

(2) Department of cartography of soils.

(3) Department for studying the genesis and classification of soils.

(4) Department for studying soil geography and geobotany.

(5) Department for studying soil-dynamics, with an experimental station.

The museum of the Institute was specially devoted to a magnificent exhibition demonstrating the state of soil science in U.S.S.R. and the number and variety of soil types. the exhibit was in three sections:

(a) Maps: the latest maps (soil, geological topographic, climatic) of the Union and also a series representing the historical development of soil investigation.

(b) General: here were shown soil properties, colour standards for measuring soil colour, structure, weathering of rocks.

(c) Geographical section: Profiles were exhibited of the soil zones of the Union from north to south. These profiles were generally accompanied by maps showing the distribution of the soil type, topography, geology, climate; photographs showing landscape and vegetation; specimens of vegetation and parent materials (rocks). This collection has been gathered by various expeditions sent out from the Institute.

The majority of the meetings of Commission V. were held in Leningrad but a few took place in Moscow at the Conservatory. Here also a special exhibition of soil profiles, apparatus, etc., was arranged.

The problems dealt with in Commission V. were those of classification, nomenclature and mapping of soils. The many papers contributed may be summarised under the following heads:

(1) Soil Genesis, Classification and Nomenclature.

(2) Geography and Mapping of Soils.

Soil Genesis, Classification and Nomenclature. The various factors, climate, organic matter, parent material, relief, which influence the formation of soil were discussed in this section. An attempt was made by Dr. Shaw to form these factors into a general formula but this was felt to be immature. The problem as to whether outside influences or internal characteristics should be used for classification was revived in a paper on general classification by Professor del Villar. Dr. Marbut drew attention to the relation of the soil type to the environment and more especially to the effect of vegetation on the type. In the case of the brown earths and podsol soils this seems to be very important. Dr. Crowther in an interesting paper tried to find a mathematical correlation of climate, clay composition and the soil type.

Methods of description of the soil profile were also discussed and several of the Russian workers suggested that the confusion caused by the use of the letters A,B,C, etc. might be removed by the use of the initial letter of a word describing a particular horizon in the profile, e.g. H. for humus horizon, E. for eluvial, C. for carbonate-bearing, etc. In a special series of papers by American workers on Illinois soils this same problem had occurred and numbers were used to designate the morphology. The problem of colour descriptions of the soil profile was also raised and the American system of laboratory description by the rotating disc method described. An elaboration of a method using the Ostwald colour triangle was also discussed by a Russian worker. Unfortunately the problem of a satisfactory colour description of the soil in the field is still unsettled.

Finally some of the Russian scientists in a series of papers described the soil conditions of the U.S.S.R., in relation to the topography, geology and climate.

Geography and Mapping of Soils. In this section several contributions were made on the geographic distribution of soil types. Besides reports on regions in the U.S.S.R., several other countries such as China, Madagascar and Chili were also discussed. The principal subject in this section however was the discussion on general soil maps of the continents, particularly of America, Asia and Europe.

Dr. Marbut reported on the progress of mapping in the U.S.A. and also of the progress in S. America.

Professor Polynov of the Dokuchaiev Institute, who is in charge of the commission for the study of the map of Asia dealt with the progress of this investigation mainly in Japan, India and China. A preliminary report has been published of this work.

It was agreed at the Washington Congress in 1927 that an attempt should be made to compile a second map of the soils of Europe on a larger scale than the first. The scale fixed upon was 1 : 2,500,000 or four times larger than that of the first map. Professor Stremme gave a report on the state of the map. Most of the countries had contributed but there are several countries - Scandinavian and Mediterranean mainly - still to report. The British contribution to this map was edited by Dr. Ogg and Dr. Hart. It is hoped that the map will be ready for publication in 1931. Dr. del Villar reported on the progress of the Work of the sub commission for the study of Mediterranean soils.

The preparation of these maps is not only useful to soil workers in showing the geographic distribution of soil types but but also helps to a standardisation of description and terminology in the different countries. The discussion after the reports on these points was very valuable.

Meeting of the Sub-Commission.

The Alkali sub-commission also met and discussed papers on alkali soils of various regions.

The following were the main results of the meeting:

(a) Discussions were held on the relative importance of climate, topography, geology, vegetation in classification and mapping of soils.

(b) There is still much dispute as to the relative importance of external and internal factors in classifying soil types and also disagreement in descriptions and nomenclature by workers in different countries.

(c) The comparison of profiles and the discussion of soil maps of different countries was very valuable not only for comparative purposes but also for obtaining agreement in descriptions.

(d) The meeting with colleagues of other countries to discuss problems was of great value.

Second International Congress of Soil Science.

Report of Excursion through U.S.S.R.

31st July - 24th August, 1930.

The principal object of the excursion was to give the foreign delegates an opportunity of travelling through the soil zones and to study the soils in the field. Since the zonality of soils according to climate has been most developed in Russia - and indeed was initiated there - the opportunity of such a tour was unique. The interest of such a visit was also increased by the detailed mapping of soils that has been done in that country.

The organising committee in U.S.S.R. of the Congress had prepared a guide book for the excursion and in this a complete description of the soils examined, the vegetation, local climate and geology is given. The book forms a very valuable contribution to our knowledge of Russian soils and the progress of their investigation. It is not necessary, therefore, to give a detailed account of every soil type and it is only proposed to summarise the methods of examination and classification of the soils and to discuss the results of the tour.

Method of Examination and Classification of Soils in U.S.S.R. For the examination of the soils pits had been dug, generally about six feet in depth though occasionally deeper, or natural sections in the banks of streams of road cuttings exposed so that the complete profile from the soil to the parent material could be studied. This profile is then divided into horizons (layers) according to various characteristics such as colour, content and kind of organic matter, structure texture, accumulation of salts, concretions, parent material, presence of water table, etc. Characteristic profiles of the soil types are described in the guide-book.

In 1879 a classification of the types of soil to be found in Russia on a climatic basis was made and all subsequent classifications have had this idea as a basis. Various causes have contributed to this development. The vast Russian plain stretching from the Arctic to the Caucasus consists mainly of a covering of sedimentary rocks lying horizontally. These rocks have been worn down by denudation and nowhere exceed a height of 1200 feet. Only in the east and south-east has folding occurred with production of the Ural and the Caucasus Mountains. The whole country to a line running from Kiev to Kazan has been glaciated so that glacial deposits are found stretching far south over the solid rocks. South of this line occur vast areas of loess to the south of which lies the arid steppe region. The parent material of the soils is therefore fairly uniform over wide areas.

On the great plains far from the sea and unprotected by mountains the heat of summer and the cold of winter are alike extreme. During the former season the isotherms run from south-west to north-east and in July range from 48°F. to 80°F. In winter the isotherms run from north-west to south-east and range from 0°F. to 32°F. The rainfall occurs chiefly in summer and is heaviest (20 - 24 ins.) in the west and centre. The topographic conditions over this broad plain have thus resulted in a zonality of climate from the arctic north to the sub-tropical south.

This zonality is also reflected in the vegetation. Along the Arctic and stretching as far south as the 66th parallel stretches the tundra. South of this lies the forest region, the taiga, now partly cleared, characterised by the pine, the fir and the birch in the north and in the south by deciduous trees. To the south is the fertile steppe with islands of trees in the north but mainly with grass vegetation while in the extreme south-east occurs the semi-desert with very scanty vegetation.

While all these causes have therefore contributed to the development of belts of soils characterised by the climate zones it must be remembered that the soil types are complexes in the main determined by climate but also modified by geology, topography and vegetation.

Route of the Excursion. While the Congress met in Leningrad and in Moscow excursions were made to the surrounding districts to examine the soils. Then by train the main excursion went to Voronez and thence to Saratov on the Volga. The party proceeding by boat to Stalingrad and then travelled across country to Rostov on the Don and then to the foothills of the Caucasus at Pieligorsk.

The journey through the Caucasus was made by car to Tiflis and by train to Batum. The Crimea was reached by boat to Yalta. From Sevastopol the route passed north through the Ukraine to Kharkov and Kiev where the excursion finished. The writer also visited the semi-desert east of the Volga (Kirghiz steppe) and also the arid region around Baku on the Caspian.

General Description of the soils examined. The route of the excursion traversed all the soil zones of the Russian plain except the tundra of the north. When crossing the Caucasus the vertical zonality of soils was also studied from the Caspian desert to the Alpine meadows. The direction of the route Leningrad to Stalingrad ran perpendicularly to the latitudinal distribution of the soil zones. This sequence of the climatic soil types was shown very clearly. Various natural causes have contributed to this result: continental climate, little influenced by sea or by mountainous topography and uniformity of parent material over vast areas.

From the Polar sea to the Caspian the following succession of climatic soil zones is observed:

1. Tundra.
2. Podsol.
3. Chernosem or Black earth.
4. Aria soils (chestnut, brown and grey).
5. Red soils.

In the Caucasus these are supplemented by vertical zones revealing in the main the same succession from the uplands downwards, i.e. from the mountain meadow soils to the steppe soils.

About one half of the Russian plain belongs to the podsol zone and one third to the chernosem. The remaining area is mainly made up by the soils of the arid regions, the red soils being very limited in distribution.

The Tundra Zone. This zone was not visited but here the soils consist of rock material with a scanty covering of arctic vegetation, lichens, mosses, etc. In the south bog soils and peaty podsolised soils occur. This zone stretches as far south as 66°N.L.

The Podsol Zone. The podsol zone is spread over a large part of the country. The southern boundary of the zone runs W.S.W. - E.N.E. along the line Kiev-Tula - Kazan - Sverdlovsk, i.e. as far south as 50°N.L. in the west and 55°N.L. in the east. The southern boundary is, however, very undulating.

True podsol is but the extreme member among the range of soils of this zone, where various modifications of the podsol are found ranging from true podsol to very slightly podsolised soil and with varieties towards peat podsols and bog soils. These modifications are found to depend on geology and topography especially micro-relief. For more detailed description these soils are sub-divided according to degree of podsolisation, texture, geology of parent material.

These soils were examined in excursions from Leningrad and also Moscow.

The Chernosem Zone. Between the podsol zone and the true chernosem zone occurs a zone of soils called the forest steppe zone. The soils here are considered to have been at one time true chernosem or black earth soils but through increasing humidity of climate the forests generally advanced south and these soils became degraded and subjected to the podsolisation process, being transformed to grey forest-steppe soils. These soils were examined in the neighbourhood of Starojilovo.

The whole chernosem zone (together with the forest-steppe zone) has a breadth of 1,200 miles in its central part, i.e. from Voronez to Rostov and in the Ukraine. This soil type has been very carefully investigated since it is the main basis of agriculture in U.S.S.R.

The following characteristics serve to distinguish this important soil type:

(1) A relatively high humus content (4 - 18%), occurring uniformly distributed throughout the upper layer.

(2) Reaction neutral to weakly acid, the absorbing complex being saturated with calcium.

(3) Granular or cloddy structure in the humus horizon.

(4) The upper humus horizon passes gradually into a lower horizon free from humus but containing an accumulation of calcium carbonate. Lower still occurs gypsum.

(5) The thickness of the humus horizons and the depth of the salt (carbonate and sulphate of calcium) accumulation varies within small limits.

(6) Low breaking down of the alumo-silcates.

(7) Development on various types of parent material though mainly on Quarternary clays and loams.

It is generally developed in a region characterised by grass vegetation and a continental climate with cold winters and comparatively warm summers.

Since the climatic conditions vary throughout the region and modifications are caused by local topographical and geological factors several sub-types are found. The division is generally made on the thickness of the humus horizon and the depth of the layer of accumulation of salts.

(a) Northern zone of leached chernosem, with slightly decreased thickness of humus horizon and a lower level of salts.

(b) Thick chernosem, very rich in humus.

(c) Ordinary chernosem.

(d) Southern chernosem, with a decrease in thickness of the humus layer and a higher level of salts.

This zone is the chief grain producing area of the U.S.S.R. and in many parts especially in the south prairie-farming is being developed, machinery being largely utilised.

Chestnut and Brown Soils of the Arid Steppes. This zone extends in a semicircular belt round the northern end of the caspian depression. The soils here are characterised by low humus content and by little leaching of the salts of the parent material. The soils are generally grey-brown, brown, and chestnut-brown in colour. These soils were met with when passing from Saratov to Stalingrad and also in the south. A more extreme variety was also examined on a visit to the semi-desert region east of the Volga (Lake Elton District) where salt lakes are found. The climate here is extreme, the rainfall (8 - 10 ins.) occurring mostly in the summer. Alkali soils, solonets and solonchak varieties are found, with salt inflorescences at surface. The region is infertile, the vegetation consisting of wormwood scrub and narrow leaved grasses, micro-relief playing a prominent part in their distribution.

Red Soil Zone. These soils were examined near Batum on the Black Sea and also in the southern Crimea. The climate here is humid sub-tropical. The average annual temperature is 13° - 14°C. and the winter is mild with much rain. The rainfall is 8 - 10 ins. The rocks are subjected to intense weathering so that a deep weathered crust is found, red, brown or yellow in colour. This type of weathering is allied to the tropical and the products to the laterites. The chemical weathering results in complete oxidation, with leaching out of CaO, Na_2O and SiO_2 and a considerable accumulation of F_2O_3 and Al_2O_3 in the upper horizons. These soils are at present being cultivated for tea, mandarins, etc.

Vertical Soil Zones. While in the region of the Caucasus and travelling from Kislovodsk to Tiflis (Georgia) and eastwards to Baku an opportunity was afforded of studying the series of vertical soil zones-dependent on variation of climate with altitude - from the Caspian desert to the Alpine meadows of the mountains. Here many intrazonal types such as the humus carbonate soils, forest soils etc., were seen. It was noticed that in this region geology had a preponderating influence on the soil type and that classification within the types was made on a geological basis.

Influences other than climate. The excursion amply demonstrated how well founded is the Russian classification on a climatic basis. Not only was the marked distribution of the soils of the humid and arid zones shown but also the continuity of the soil type along the climatic zone. The climatic basis is therefore very valid for the widest grouping of soils.

It was very apparent, however, that other influences were continually at work modifying the soil type and that any one zone is made up of a complex of soils. Such influences are geology, topography and vegetation.

In every area visited the influence of geology was seen either in modifying the landscape and through this the soil or directly affecting the soil by reason of the texture and composition of the parent material. This was specially marked in the more hilly districts of the country. For sub-dividing the soil types geology is of great importance and in a country such as Scotland with varied relief and only a limited number of soil types geology might usefully be applied for classification within the type.

The influence of relief and especially of micro-relief is associated with variations in the water table and drainage and therefore has an important effect on the soil. Instances of this were seen in the podsol zone where the soils in hollows were darker, containing more humus, and wetter than those on the higher ground. Effects of the relief on the soils and on the vegetation were also seen in the arid zones.

The influence of vegetation, which reflects the climate was also apparent and differences were useful in mapping the soil types. The effect of encroachment of forests on the black earth has already been mentioned. Here the soil type is profoundly modified by the forest. In the Kirghiz steppes also it was noted that the solonets soils were occupied by the worm-wood scrub while the grasses were found in the slight depressions so that the vegetation differences were sufficient to distinguish the soils.

Changes in the soil due to cultivation and deafforestation were also observed.

Soil Science and Agriculture.

At present agriculture in Russia is being extensively industrialised. An attempt is being made to collectivise the peasant small holdings and to develop large scale farming, especially in the grain areas of the south-west. The peasants are being asked to pool their resources and land to form communal farms on which machinery may be utilised. The development of the use of machinery is being made as fast as the resources of the country will permit. At present only about 25% of the peasants are grouped in these collective units.

Not only in the development of new regions but also in the cultivated areas are the results of the investigations of soil scientists being utilised. This work, the study of the genesis of soils, their classification and mapping is of great importance in this development and much of the responsibility of its success rests on the shoulders of the soil scientists. From their results is made the selection of suitable crops for the soil regions, questions of tillage and drainage settled and the selection of suitable manures for the particular crop made. For a general survey for this purpose maps are made on a scale of 1: 50,000 or 1: 100,000 but for more detailed purposes a scale of 1: 10,000 or 1: 5,000 is used.

The following are the main points arising from the tour:

(1) Value of examining the complete soil profile from the surface soil to the parent material.

(2) The importance of the climatic grouping of soil types and also the effect of geology, relief and vegetation in modifying the type.

(3) The need for co-ordination among the soil workers of different countries in description of soil types. It was a very valuable experience to have workers from various countries stating their views in the field.

(4) The importance of the study of the soil as a natural body and the value of classification and mapping of soils as a basis for land utilisation. By means of such surveys the resources of the soil may be better used.

(5) Problems of irrigation in arid regions and the utilisation of alkali soils.

(6) The benefit of a central organisation and research departments for studying soil problems.

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